

THE LIFE HISTORY AND BEHAVIOR OF *EPIMARTYRIA PARDELLA* (MICROPTERIGIDAE)

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ABSTRACT. Adults of *Epimartyria pardella* (Walsm.) are rather sessile and exhibit a clumped distributional pattern. Moths are active during the day and usually closely associated with liverworts. Larvae from eggs deposited in the lab feed on liverworts. There are three larval instars and in captivity 1.75 years were spent in the larval stage. Collection of wild larvae suggest that 2 years are also required to complete development under natural conditions.

The family Micropterigidae is recognized as the most primitive group of Lepidoptera known. The adult moths are the only Lepidoptera with functional mandibles which they use for feeding on pollen. Micropterigidae are aglossate, jugate moths whose closest relatives are believed to be the Heterobathmiidae. Chapman (1917) and Hinton (1946) placed the Micropterigidae in their own order, the Zeugloptera, because of the primitive characters the larvae express, but Common (1970), Kristensen (1971) and Richards and Davies (1959) treated the Zeugloptera as a suborder of Lepidoptera. Fossil micropterigids in lower Cretaceous amber indicate that relatively little change has occurred in the group during the last 135 million years (Whalley, 1977, 1978).

In the United States this unique suborder is represented by the new world genus *Epimartyria* Walsm. (1898) that consists of two species. A great deal of work has been done on the systematics and evolutionary status of the micropterygids (Hinton, 1958; Common, 1975; Heath, 1976; Whalley, 1978; Kristensen and Nielsen, 1979), but observations dealing with their behavior and habitat are for the most part lacking. In this paper, information is presented on the biology and habitat of *Epimartyria pardella* (Walsm.).

The type series of *E. pardella* consists of five specimens which were collected near the coast in southern Oregon during early June 1872. The description that Walsingham (1880) published is brief and accompanied by a color illustration. The moth (Fig. 1) has a wingspan of 10 to 11 mm. The forewing is metallic brown with three distinctive gold spots, while the hind wings are only metallic brown. The fringe of both

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fore and hindwings is yellow and brown. The abdomen and thorax are gray-brown; the legs and a portion of the head are golden yellow. From the head to the posterior tip of the abdomen the moth measures just under 3.5 mm.

Last Instar Larva

Head. Length 0.5 mm, diameter 0.27 mm. Brown. Antennae prominent, trisegmented and situated on small tubercles located on dorsal lateral portion of head (Fig. 3). Stemmata with 5 facets and located at the base of the antenna. Labrum simple with a pair of trisegmented palpi. Mandibles simple and dark brown.

Body. Length 4.3 to 4.6 mm; width 1.4 mm; height 1.2 mm. The body tapering at both ends with highest and widest point at abdominal segment 4. Dorsal and lateral surface brown to dark brown, ventral surface light brown. Prothoracic shield with 10 peg-like setae, 8 on the anterior and lateral border and 2 dorsally. Prothorax distinctly narrower than mesothorax. Mesothorax with 8 setae, 6 on dorsal and lateral anterior portion of gray brown pigmented area, and 2 just ventral to this pigmented area. Setae of metathoracic segment similar to those of mesothorax except subdorsal seta is greatly reduced in size. All thoracic segments have additional small micro-seta just dorsal to each true leg. True legs brown, with 3 segments and simple claw. Abdominal segments (A) A1 to A8 (and T2 and T3) with sawtooth-shaped knobs which form a dorsal and lateral ridge, areas between ridges concave. The middorsal area concave and small dark depression occurring on posterior of segments T2 to A8. Segments A1 to A8 each with one dorsal seta (0.18 mm) atop dorsal ridge. Segments A1 to A8 with reduced, almost microscopic subdorsal seta (0.04 mm) and prominent lateral seta (0.12 mm) on lateral ridge. Dorsal, subdorsal and lateral setae occur in brown pigmented area which has rough and wrinkled appearance. Dorsal and lateral intersegmental area constricted and may contain series of 8 to 20 microscopic dots. Ventral to lateral ridge, cuticle smooth and light brown. Series of brown dots form pattern around fixture that usually support a small seta. Conical ventral "prolegs" occur on segments A1 to A8 and small sclerotized protuberance appears on ventral surface of each. Segments A9 and A10 fused and with enlarged simple sucker. Spiracles posterior and ventral to lateral setae. Head diameter of first and second instar larvae 0.11 and 0.22 mm, respectively.

Habitat

Observations were made in Prairie Creek State Redwood Park, Humboldt County, California. All locations where adults were observed or captured were within a few km of the ocean and at relatively low elevations. Although some moths were found along creeks and moist hillsides in the redwood-fir forest, the preferred habitat appears to be steep-walled, moist canyons near the coast which are dominated by ferns and bryophytes (Fig. 6). The prominent bryophytes that are associated with the adults and larvae are, *Conecephalum contium*, *Pellia* sp., *Hookeria lucens*, and *Atrichum undulatum*. Other plants in the immediate area include: bracken fern, *Pteridium aquilinum*; sword fern, *Polystichum minitum*; deer fern, *Blechnum spicans*; and five-finger fern, *Adiantum pedatum*.

Climatic conditions in this area are moderate and stable. Weather records from Prairie Creek Campground, located about 4 km east of the beach at an elevation of 160 m indicated the mean daily temper-



FIGS. 1-5. 1, Adult male *E. pardella* (14 \times); 2, ova on underside of liverwort thallus (8 \times); 3, last instar larva (9 \times); 4, cocoon (5 \times); 5, pupa (9 \times).

ature for January (9.5°C) and July (15.5°C) of 1981 differed by only 6°C. Although the summer months (June to September) are relatively dry, approximately 140 cm of rain falls between October and May. During the 1980-81 rainy season (October to May) there were 12 days when the temperature dropped below 0°C (32°F); the lowest temperature recorded during that time was -1.5°C (28°F). Barbour et al. (1973) suggested that seasonal temperature fluctuation reaches a min-



FIG. 6. Habitat of *E. pardella* in Northern California.

imum in this area because of off shore upwelling. They indicated that the mean monthly air temperature normally changes only a few degrees between the coldest and warmest months, and the ocean temperature changes very little.

Adult Behavior

The flight season begins in late May and continues to early or mid-July, with the peak adult density in June. The moths are active during the day, generally between 0900 and 1930 h, but this is influenced by temperature, humidity, and light intensity. When abundant, adults may be observed perched on vegetation; at low densities the best means of locating a colony is by sweeping suitable habitat with an aerial net. Behavioral notes were made on the activities (*in situ*) of individual moths that were observed from one to seven hours.

In areas protected from wind, adults frequently perched on the upper surface of fern fronds or other plants near patches of liverworts growing on canyon walls or beside creeks. Adults exhibit a clumped distributional pattern and, where common, densities reached 6 moths/m². When windy, or if the humidity is low, adults find shelter among the moist bryophytes with which they are always closely associated. The antennae are held at a 45 to 60 degree angle above the midline of the body while the moths are perched (Fig. 1). As they walk, the

antennae wave up and down often touching the substrate. The hind legs of *pardella* are almost equal in length to that of the entire moth, and are occasionally used to jump or hop a few centimeters. Adults may remain motionless for hours and then walk or fly a few centimeters and perch again. During a single two and one half hour observation, a moth traveled 25 cm in a sporadic pattern and came to rest for the evening less than 5 cm from where it was first observed. Another moth less than 50 cm away walked less than 15 cm during this time. Most moths in 1981 were observed from one to three hours and traveled less than 30 cm. In 1982, five moths were carefully observed for a total of 29.2 hours. Again, the adults were extremely sessile, often remaining for hours in the same position. During the 29.2 hours, 16 flights were observed with an average distance of 21 cm per flight; they walked an average of 17 cm. Moths changed positions to perch in sunny locations, to avoid predators, and in the case of females, to oviposit. Adults are the prey of various small predators. One moth was captured in a spider web and another chased by a small hunting spider of the genus *Theridion*. A third moth was stalked but not captured by a small Olympic salamander (*Rhyacotriton olympicus*). Moths fly when disturbed but normally flight is infrequent and brief; the flight pattern is fluttery and weak but usually direct.

Adult micropterigids of other genera are reported to feed on pollen rather than nectar and have unique mouthparts. The mandibles are well developed, and the hypopharynx is concave on the upper surface. As pollen grains are ingested they are ground by the action of the mandibles against the hypopharyngeal spines and then digested (Tillyard, 1923; Hannermann, 1956). European species have been collected at the blooms of many plant species, including: Compositae, *Acer*, *Carex*, Scrophulariaceae, *Quercus*, and *Ranunculus* (Heath, 1960). Although various *Ranunculus*, Compositae, and Scrophulariaceae were near by and in bloom, no moths were observed at the flowers. Adults were frequently observed drinking water. Since they lack a proboscis they lower their head to the droplet of water by extending their mesothoracic legs to the side of their body. This lowers the head and raises the abdomen, allowing the moth to drink. If deprived of moisture moths die in less than two days, but when provided with water, they survived in captivity from nine to 18 days, and females deposited ova.

The only mating pair of moths was found just prior to 1000 h. In captivity females laid an average of 8.2 eggs per day. Ova were deposited on the underside of the liverwort thalli singly or in small clusters containing up to five ova (Fig. 2). The females generally remained on the upper surface and would simply swing their abdomen under the edge of the thallus to oviposit.

Immature Stages

The ova are flattened, circular and smooth when first deposited but become spherical in a short time and are covered with a series of small white projections (Fig. 2). The ova are white and measure 0.40×0.44 mm. At 22°C the eggs hatch in 21 days. The first instar larvae emerge from the side of the egg and are about 0.75 mm long. They vary from light brown to light gray and appear to have the same setal pattern and shape as mature larvae but have the ability to flatten themselves when at rest.

Larvae were reared in either a terrarium or petri dishes. Although both species of liverwort (*Conocephalum* and *Pellia*) were available, the larvae showed a marked preference for *Pellia*, the smaller of the two species. Mature larvae are active primarily at night but early instar larvae may be active at any time. While feeding, the margin of the liverwort is not damaged, rather the underside of the living thallus is eaten away but not through. Many micropterigid species feed on bryophytes, but the work of Luff (1964) and Lorenz (1961) indicates that some species do not.

In captivity the larvae are rather inactive, avoid intense light, and are usually found on the underside of the thalli during the day. In the field larvae were also found under living thalli during the day. Their coloration and size allowed them to blend well with the dead thalli which occur under the living growth. As the larva walks the true legs grasp the substrate; from above it appears to glide across the surface as the rhythmic undulations of the ventral surface are not apparent. When disturbed or inactive the head may be withdrawn so that only the prothoracic shield is visible; when extended the antennae which are located above the eyes are prominent (Fig. 3).

Unlike the European species which have a one year life cycle (Heath, 1976; Lorenz, 1961), *pardella* appears to have a two year cycle. In captivity eggs deposited in June 1981 became adults in June 1983. In the field, second instar larvae were commonly collected each year during the adult flight period. These larvae must represent the offspring from ova deposited the previous year, as reared larvae one year old were also in the second instar. Davis (pers. comm.) observed that *E. auricrinella* (Walsm.) from the eastern United States also has a two year life cycle.

Pupation occurs close to the ground among vegetation. The brown cocoon, which measures 5.5×4.5 mm, is oval, thin walled and tightly woven (Fig. 4). Strands of coarse silk attach the cocoon to vegetation. The exarate pupa is white to light brown (Fig. 5).

Based on the illustration of *Micropterix calthella* (L.) larvae by Lorenz (1961), the larvae of *E. pardella* exhibit a number of differences.

The setae of *calthella* are club-shaped and apparently uniform in length. The larvae of *pardella* have peg-shaped setae which vary in length according to their location. In addition, the distribution of the larval setae and pupal setal patterns also differ. A preserved pupa, cocoon, and larvae were deposited in the collection of the California Academy of Sciences, San Francisco.

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